CLAIMS

What is claimed is:

1. A system for assisting the maintenance of balance, comprising:

a plurality of sensors configured for placement as a two-dimensional array under at least one foot of a user, wherein each sensor within said plurality of sensors transduces a detected magnitude of forces applied to said sensor, and wherein said plurality of sensors generate balance information signals representing said detected magnitude of forces applied to said each of said plurality of sensors;

a signal processing subsystem operative to receive said balance information signals from said plurality of sensors and to convert said balance information signals into stimulation control signals, the stimulation control signals collectively encoding the magnitude of the pressure under said foot and the radial position and angular position of the center of pressure under said foot; and

a plurality of stimulators for placement on said user, the stimulators being responsive to said stimulation control signals to stimulate said user in a manner indicative of the magnitude of the pressure under said foot and the radial position and angular position of the center of pressure under said foot.

2. The system of claim 1 wherein said plurality of sensors are sensitive to forces oriented perpendicular to said plurality of sensors.

3. The system of claim 1 wherein said plurality of sensors are sensitive to forces oriented parallel to said plurality of sensors.

4. The system of claim 1 wherein said plurality of sensors are sensitive to forces oriented parallel to said plurality of sensors and forces oriented perpendicular to said plurality of said plurality of sensors.

5. The system of claim 1 wherein said plurality of sensors are mounted in a shoe.

6. The system of claim 1, wherein said plurality of sensors are mounted in a stocking.

7. The system of claim 1, wherein said plurality of sensors are mounted in a sandal.

8. The system of claim 1, wherein said plurality of sensors are insertable into a shoe.

9. The system of claim 1, wherein said plurality of sensors are insertable into a stocking.

10. The system of claim 1, wherein said plurality of sensors are insertable into a sandal.

11. The system of claim 1, wherein said plurality of sensors are insertable into skin of said user.

12. The system of claim 1, wherein said plurality of sensors are insertable under skin of said user.

13. The system of claim 1, wherein said plurality of sensors are insertable within a body of said user.

14. The system of claim 1 wherein said signal processing subsystem is further operable to:

convert said balance information signals received from said plurality of sensors into at least one estimate of a magnitude of force applied to a sole of said at least one foot; and

wherein said stimulation control signals encode said magnitude of force applied to said sole of said at least one foot.

15. The system of claim 1, wherein said signal processing subsystem is further operable to:

convert said balance information signals into at least one estimate of a position of force applied to a sole of said at least one foot; and

wherein said stimulation control signals encode said position of force applied to said sole of said at least one foot.

16. The system of claim 1 wherein said signal processing subsystem is further operable to:

convert said balance information signals into at least one estimate of an orientation of force applied to a sole of said at least one foot; and

wherein said stimulation control signals encode said orientation of force applied to said sole of said at least one foot.

17. The system of claim 1, wherein the signal processing subsystem is further operable to:

convert said balance information signals into at least one estimate of a portion of a total body weight of said user applied to a sole of said at least one foot; and

wherein said stimulation control signals encode said portion of said total body weight of said user applied to said sole of said at least one foot.

18. The system of claim 1, wherein said signal processing subsystem is further operable to:

determine a magnitude of a resultant reaction force applied to a sole of said at least one foot by

calculating a sum equal to the total force applied to all sensors within said plurality of sensors, and

dividing said sum by a total body weight of said user.

19. The system of claim 1, wherein said stimulators are securable to a leg of said user.

20. The system of claim 1, wherein said stimulators are incorporated into a stocking.

21. The system of claim 1, wherein said stimulators are implantable into skin of said user.

22. The system of claim 1, wherein said stimulators are implantable within the body of said user.

23. The system of claim 22, wherein said stimulators are placeable proximate with at least one sensory neuron of said user.

24. The system of claim 22, wherein said stimulators are placeable proximate with at least one sensory nerve of said user.

25. The system of claim 1 wherein said stimulators are operable to produce vibrational stimuli.

26. The system of claim 1, wherein said stimulators are operable to produce electrical stimuli.

27. The system of claim 1, wherein said stimulators are operable to produce electrocutaneous stimuli.

28. The system of claim 1, wherein said stimulators are operable to produce auditory stimuli.

29. The system of claim 1, wherein said stimulators are operable to produce visual stimuli.

30. The system of claim 1, wherein said at least one stimulator is operable to produce thermal stimuli.

31. The system of claim 1, wherein said stimulators are configured for placement on at least one leg of said user.

32. The system of claim 1, wherein said stimulators are configured for placement on the trunk of said user.

33. The system of claim 1, wherein said stimulators are configured for placement on the head of said user.

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34. The system of claim 1, wherein said stimulators are mountable proximate to a leg of said user in a plane substantially parallel to a plane of an ipsilateral foot sole.

35. The system of claim 1 wherein said stimulators are operable to stimulate a sole of said at least one foot.

36. The system of claim 1 wherein said stimulators are responsive to said received stimulation control signal such that stimulus amplitudes, frequencies, and locations are indicative of at least one parameter describing forces applied to a sole of said at least one foot.

37. The system of claim 1, further comprising:

at least one goniometer for transducing an angle between at least one foot and the ipsilateral lower leg, and for transmitting an ankle angle signal to said signal processing subsystem; and

wherein said signal processing subsystem receives said ankle signal, and determines said stimulation control signals, at least in part, responsive to said ankle angle signal.

38. The system of claim 1, further comprising:

at least one goniometer for transducing an angle between at least one lower leg and the ipsilateral upper leg, and for transmitting a knee angle signal to said signal processing subsystem; and

wherein said signal processing subsystem receives said knee angle signal, and determines said stimulation control signals, at least in part, responsive to said knee angle signal.

39. A system for assisting the maintenance of balance during standing or gait, comprising:

at least one sensor for transducing an angle between at least one foot and an ipsilateral lower leg of a user, and for transmitting at least one balance information signal representing said angle;

a signal processing subsystem operative to receive said balance information signal and to convert said at least one balance information signal into stimulation control signals, the stimulation control signals collectively encoding said angle between said at least one foot and said ipsilateral lower leg of said user; and

a plurality of stimulators for placement on said user, the stimulators being responsive to said stimulation control signals to stimulate the user in a manner indicative of said angle between said at least one foot and said ipsilateral lower leg of said user.

40. The system of claim 39, wherein said at least one sensor is operable to determine angles between said foot and said ipsilateral lower leg of said user projected onto a sagittal plane with respect to said user.

41. The system of claim 39, wherein said at least one sensor is operable to determine angles between said foot and said ipsilateral lower leg of said user projected onto a coronal plane with respect to said user.

42. The system of claim 39 wherein said at least one sensor is insertable into a shoe.

43. The system of claim 39 wherein said at least one sensor is insertable into a stocking.

44. The system of claim 39 wherein said at least one sensor is mounted within a shoe.

45. The system of claim 39 wherein said at least one sensor is mounted within a stocking.

46. The system of claim 39 wherein said signal processing subsystem is further operable to:

convert said balance information signal into at least one estimate of a magnitude of an angle between said at least one foot and said ipsilateral lower leg of said user; and

wherein said stimulation control signals encode said magnitude of said angle between said at least one foot and said ipsilateral lower leg of said user.

47. The system of claim 39 wherein said stimulators are removably affixed to said ipsilateral lower leg of said user.

48. The system of claim 39 wherein said stimulators are incorporated into a stocking.

49. The system of claim 39, wherein said stimulators are implantable into skin of said user.

50. The system of claim 39, wherein said stimulators are implantable under skin of said user.

51. The system of claim 39, wherein said stimulators are implantable within a body of said user.

52. The system of claim 39, wherein said stimulators are placeable proximate to one or more sensory neurons of said user.

53. The system of claim 39, wherein said stimulators are placeable proximate to one or more sensory nerves of said user.

54. The system of claim 39, wherein said stimulators are operable to produce vibrational stimuli.

55. The system of claim 39, wherein said stimulators are operable to produce electrical stimuli.

56. The system of claim 39, wherein said stimulators are operable to produce electrocutaneous stimuli.

57. The system of claim 39, wherein said stimulators are operable to produce auditory stimuli.

58. The method of claim 39, wherein said stimulators are operable to produce visual stimuli.

59. The system of claim 39 wherein said stimulators are operable to produce thermal stimuli.

60. The system of claim 39, wherein said stimulators are afixable to at least one arm of said user.

61. The system of claim 39, wherein said stimulators are afixable to a head of said user.

62. The system of claim 39, wherein said stimulators are afixable to a trunk of said user.

63. The system of claim 39, wherein said stimulators are placeable on at least one leg of said user in at least one plane approximately parallel to a plane of the ipsilateral foot sole.

64. The system of claim 39, wherein said stimulators stimulate a sole of said at least one foot of said user.

65. The system of claim 39, wherein said stimulation control signals are indicative of angles between said at least one foot and said ipsilateral lower leg of said user.

66. The system of claim 39, further comprising:

a plurality of force sensors for detecting balance information, wherein said plurality of force sensors is configured for placement under said at least one foot of said user, wherein each force sensor within said plurality of force sensors transduces a detected magnitude of forces applied to said force sensor, and wherein said plurality of force sensors transmits balance information signals representing said detected magnitude of forces applied to said plurality of force sensors; and

wherein said signal processing subsystem receives said balance information signal, and determines said stimulation control signals, at least in part, responsive to said balance information signals.

67. The system of claim 39, further comprising:

at least one sensor for transducing an angle between at least one lower leg and the ipsilateral upper leg, and for transmitting a knee angle signal to said signal processing subsystem; and

wherein said signal processing subsystem receives said knee angle signal, and determines said stimulation control signals, at least in part, responsive to said knee angle signal.

68. The system of claim 1 wherein said stimulation control signals further encode the time derivatives of the magnitude of the pressure and of the radial position and angular position of the center of pressure under said foot.

69. The system of claim 1 wherein said stimulation control signals further encode the time integral of the magnitude of the pressure under said foot.

70. The system of claim 39 wherein said stimulation control signals further encode the time derivatives of the radial position and angular position of the center of pressure under said foot.